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Vol.		Vol.	
1.	3 numbers, 1928.	11.	4 numbers, 1940 (none).
2.	4 " 1929.	12.	4 " 1941 (none of Nos. 1 and 2).
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ISSUES OF THE AGRICULTURAL CIRCULAR.

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Vol. 1, 1920, 12 numbers.	Vol. 4, 1923, 1 number.
2, 1921, 5 "	5, 1924-5, 2 numbers.
3, 1922, 4 "	

As number 4 of Vol. 3 was printed as " Volume 4 " and number 1 of Vol. 4 as " Volume 5 " it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume 5, No. 1.

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THE Annual Bulletin of Divisional Reports ran from 1931 to 1938 and was then discontinued.

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FREE copies of the following Bulletins are available to Colonial Departments of Agriculture research institutes and bona fide planters within the Colony.

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 24. The Botanical Gardens, Suva, 1948. Price 1s. 6d.

Applications should be made to the Librarian, Department of Agriculture, Suva, Fiji.

—EDITOR.



Agricultural Journal

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EDITORIAL

In an earlier issue of the Journal mention was made of the papers contributed by officers of the Fiji Government and read before the Seventh Pacific Science Congress held in New Zealand in 1949. It is proposed to publish some of these papers in the Journal and a fitting introduction is made in this number with the Deputy (now Acting) Director's paper on "Agricultural Policy and Research in Fiji", and the Conservator of Forest's paper on "Forestry Problems in the South Pacific".

Readers will appreciate the close inter-relationship between forest policy and productive potential in a country like Fiji. Without the former to maintain, or recover, the balance of nature, agricultural policy must be seriously handicapped, and may even eventually be frustrated through the climatic changes dependent on the loss of forest cover.

In his paper, Mr. W. J. Blackie traces the development of agriculture (and especially Government policy in agriculture) from the days of the early settlers up to the present time. One gains the impression that the more diversified farming which is gradually taking the place of the earlier monocultural system, has much to recommend it. The failure of the cotton market at the end of the American Civil War, the periodic slumps in the price of copra and the banana marketing difficulties each point to the danger of having all one's eggs in the same basket. Notwithstanding set-backs of this nature, the record of achievements both in the raising of crops and in the control of pests and diseases may well strike the reader as being, for such a small country, not without honour.

The Conservator of Forests in his paper on "Forestry Problems of the South Pacific" naturally emphasizes man's capacity for the destruction of land fertility rather than his skill in husbandry, and points out the grim consequences of denuding a country of its trees, whether through ignorance or greed. He describes the advent of the European trader and his exploitation of the sandalwood forest, followed by the settler with his unthinking onslaught on "the bush"; the Indian immigrant whose care for the soil is lessened by the insecurity of his tenure, and not least the Fijian who "burns off" indiscriminately in his search for wild yams and to graze his stock. Remedies are prescribed for dealing with these problems, which have origins as diverse as economics, sociology and religion, and consequently require to be handled with tact and understanding, no less than with firmness.

The two papers, happy in their juxtaposition, provide much food for thought, and encouragement for action which will lead to greater well-being in these islands.

—M.C.D.

STAFF NOTES

Mr. T. L. Mune was transferred to Queen Victoria School, Lodon, as Farm Manager, with effect from 1st July, 1949.

Mr. D. J. G. Davies retired from his post as Livestock Officer with effect from 7th October, 1949.

Mr. J. R. Campbell was appointed Agricultural Assistant with effect from 3rd October, 1949.

Mr. N. Lamont arrived in the Colony on 26th September, 1949, to take up his appointment as Agricultural Officer.

Mr. T. P. Gardiner, Senior Livestock Officer, proceeded on leave to Australia on 12th October, 1949.

Mr. J. W. Gittins was assigned to the Southern District as District Commissioner Southern with effect from 1st September, 1949.

Mr. C. R. Turbet, Senior Veterinary Officer, was transferred to Nyasaland Protectorate with effect from 30th November, 1949, Mr. K. J. Garnett, Veterinary Officer, being appointed to act as Senior Veterinary Officer from that date.

Mrs. B. J. Smith was appointed Temporary Clerk as from 16th November, 1949.

Miss M. W. Green resigned from her post as Temporary Clerk with effect from 25th November, 1949, and has returned to New Zealand.

AGRICULTURAL RESEARCH AND POLICY IN FIJI

BY W. J. BLACKIE

It is with some diffidence that I venture a contribution to the Seventh Pacific Science Congress on the subject of Agricultural Research and Policy in the Colony of Fiji.

It is usual to expect at such a gathering of scientists something in the nature of original contributions in one of the several fields of science with which the congress is concerned; however, I am persuaded that one of the main purposes of such gatherings is also the free exchange of opinions and information regarding research problems, and the policy and organization which in the light of experience has proved satisfactory for the needs of the administration concerned.

Fiji is a small country and in common with other Pacific Islands, is entirely dependent on its agricultural production which in the main constitutes its only source of income. Secondary industries are few and are chiefly concerned with the processing of primary products. The discovery of gold in Viti Levu has broadened, somewhat, the overall economy, but as a vanishing or localized asset, its importance to the future development of the Colony must not be over-emphasized. Apart from a limited quantity of low-grade phosphate, which may be suitable for local agriculture, no other mineral deposits have been discovered in sufficient quantity to warrant commercial exploitation.

With soil as the main raw product, with a rapidly increasing population on a small land area, the development of systems of agriculture which have as their basis the preservation of this natural resource and the adequate provision of nutritionally sound food, and cash crops—to make available improved social services—are of paramount importance to Fiji and to other island territories of the South Pacific region with similar problems.

Within recent years the Government has given careful consideration to the circumstances of agriculture and with a full

appreciation of changing conditions, and with the assistance and experience of local agricultural officials, members of the farming community and overseas investigators, there has been evolved an agricultural policy and plan of action which it is considered will meet the agricultural conditions as they exist to-day and future trends that can with reason be anticipated.

In order to explain this policy it is necessary to diverge somewhat from the main theme for the purpose of providing an agricultural background. I propose, therefore to give a brief account of past agricultural progress and the status of agricultural industries as they exist in the Colony to-day.

Following visits by the Botanist, Dr. Seeman, and others, the agricultural potential of Fiji for plantation crops was quickly appreciated, and from 1860 settlers, chiefly from New Zealand and Australia, began to arrive in the Colony.

Dr. Seeman reported that the soils were suitable for the cultivation of cotton and other tropical crops, and during the period of the American Civil War large areas of the Colony, particularly on the rich alluvial flats of the main rivers, were planted up with cotton.

These early settlers were for the most part inexperienced in tropical agriculture; many of them were totally unacquainted with farming practices and suffered many hardships in their new environment.

Under the unsettled conditions pertaining during the period immediately following the Civil War and with the independent and inefficient labour then offering, it became impossible with reduced cotton prices to compete on the world's markets, with the result that cotton planting was completely abandoned. Many of the settlers lost their all in these preliminary agriculture endeavours and left Fiji; others who elected to remain eked out a miserable existence in experimenting with new crops.

With the cession of Fiji to the British Government in 1874 more settled conditions gave promise of plantation development and many tropical economic crops were imported including rubber, tea, coffee, cocoa, vanilla, fibres, spices, essential oil plants, and tried out with varying success. In fact as one writer of the time commented, "Fiji had become a country of experimenters".

Following cotton, coffee was developed with some success and by 1884 coffee plantations were numerous and extensive throughout the group. In that year, however, the rust *Hemileia vastatrix* was introduced in planting material, and due to the rapidity of its spread, coffee plantations were completely abandoned within a period of two years.

Rubber, cocoa and tea grew well, but never became important crops. Cocoa was badly attacked by the Indian rose beetle (*Adoretus versutus*, Har.) and all suffered from uneconomic prices in relation to cost, inefficiency, and shortage of labour. Control of the rose beetle is now effective with DDT (Lever¹).

From 1880 onwards considerable areas in Vanua Levu and Taveuni were planted up to coconuts, and this crop together with bananas and sugar-cane—which followed cotton on the alluvial flats—emerged as the main commercial plantation crops of the Colony.

At the turn of the century just prior to the founding of the Department of Agriculture, the distribution of agriculture throughout the group was approximately as follows:

On the main island of Viti Levu sugar was established in the Navua area—now held by the Fiji Pastoral Company—and on many areas such as Koronivia, Nausori, Muana-weni and other localities in relation to the alluvial flats of the Rewa River.

On the western side of the main island in rainfall belts of from 60 inches to 80 inches with a distinct dry season, sugar was successfully established on alluvial flats and up-raised sea flats in the districts of Nadi, Penang, Lautoka and Ba.

More general cropping including rice, maize and peanuts, was practiced in a few areas, chiefly at Tavua and Caboni and

cattle were being successfully raised at Yaqara. Nevertheless sugarcane cultivation was beginning to dominate the agricultural pattern in the Western and North-Western districts.

Competing with sugar on the alluvial flats of the South-Eastern districts of Viti Levu, banana cultivation was extending rapidly and considerable areas both here and on the Sigatoka flats in the South-Western districts were planted up to the three commercial varieties, Veimama, Cavendish and Gros Michel. It was at this period that the first signs of the disease called "Sigatoka" were recorded which together with "Bunchy Top" and the borer, *Cosmopolites sordidus*, threatened the extinction of the industry in later years.

A small plantation of cocoa inter-planted with Gros Michel bananas as shade was located on soapstone soils at Lami, about four miles from Suva and some 70 acres were established to the crop on lateritic soils in the wet area of Wainunu, and in several other localities associated with coconuts on the heavy loams of Savusavu Bay on the Island of Vanua Levu.

The dominant crop in the wet areas of Vanua Levu, on the island of Taveuni and in the Lau Group, was coconuts and in Taveuni cattle were associated with copra production on many of the estates.

At Labasa on the dry side of the Island of Vanua Levu in a rainfall zone similar to Lautoka on the main island, sugarcane cultivation was extended by the reclamation of considerable areas of mangrove swamp.

At Wainunu on lateritic soils of p.H. 4.5 an area of 200 acres had been planted up to tea. Under a rainfall of 175 inches to 180 inches this crop appeared to be satisfactorily established and was free from pests and diseases.

Sugar and bananas were grown under estate conditions,—European ownership and management—and labour conditions had been improved by the importation of East Indians under the indenture system. Three sugar companies controlled milling operations but the Colonial Sugar Refining Company extended its operations and ultimately assumed complete control of sugarcane production and factory practice.

On most sugar estates cultivation was thorough. Disc ploughs, sulky ploughs, subsoilers, and harrows were in use drawn by bullock or horse teams, and in the larger heavier areas, steam ploughs worked on blocks of 40 acres gave excellent service, particularly at Lautoka and Ba.

The crop rotation included a fallow and a green manure, usually Mauritius bean (*Stizolobium nivea*). Artificial fertilizers such as sulphate of ammonia or nitrate of soda were applied to well established plant cane. Other fertilizers in use included stable manure, megass ashes and filter press cake. The chief cane varieties in use in lower rainfall areas were known as Rose Bamboo, Striped Singapore, and Badilla. In the wetter areas of Navua and Rewa Malabar cane was the predominant variety although reference is made in the records to a New Guinea cane cultivated at Baulevu estate on the Rewa River.

Of considerable importance was the attention given to drainage, particularly subsurface mole-drains which at average depths of 20 inches were found to be particularly effective on the heavier low-lying soils.

On several estates, particularly those where sugarcane cultivation was also in operation, some attention was given to the proper cultural practices and management of bananas, but in general, little attention was given this crop. In the great majority of cases crop after crop was harvested without the application of fertilizers, efficient pruning or the interplanting of a green manure crop. In some cases clean weeding was practised; on most plantations, however, grass and weeds were kept down by periodical slashing. There is no doubt that the drain on the soil occasioned by these methods lessened the resistance to disease and gave opportunity to its spread.

The coconut areas in Vanua Levu and Taveuni to which I have referred were well planted at distances of 30 feet by 30 feet on the square, and surface growth was kept under control by grazing and selective weeding to improve and maintain the grass cover of *Axonopus compressus*.

The main plantings were carried out with unselected material of the tall variety; in some areas Rotuman nuts were used but no

systematic planting was undertaken with the local dwarf or Niu Leka.

As the plantation developed the attack of certain insect pests assumed importance. The chief of these were the purple moth *Levuana iridescens*, the transparent coconut scale, *Aspidiotus destructor*, the leaf miner *Promecothea reichel*, and the coconut spike moth *Tirathaba trichogramma*, Meyr. The subsequent control of these serious pests by biological means was effectively carried out by the Department of Agriculture.

This then was the agricultural position at the beginning of the century. I have dealt with this matter in rather a sketchy manner since it was not my purpose to provide an accurate historical survey of agricultural development, but rather to give sufficient information to enable an appreciation of the agricultural position and the reaction of Government to it.

Apart from a considerable increase in the production of rice—to self sufficiency at the present time—the development of a small pineapple canning industry, the creation of a small dairy industry, the expansion of the cattle industry to self sufficiency in beef and an abortive attempt to re-establish the cotton industry, further development has been in the direction of the expansion of the coconut and sugar industry. The banana industry has decreased considerably in size (but not in importance) from 1919 onwards due to the imposition by the Australian Government of a duty of 8s. 4d. per cental.

The earliest records of agricultural statistics occur in the Annual Report of the Department of Agriculture for the year 1921. Unfortunately cultivations by Fijians are not included in these returns. Acreages are available for sugar and copra, and from produce inspection returns it is possible to give a calculated minimum figure for the area under bananas in 1921. In the following table the acreages of the main crops are set out for the years 1921 and 1946:—

TABLE I.

Year.	Sugarcane Acres.	Copra Acres	Bananas Acres
1921 ..	53,008	78,500	2,900
1946 ..	64,000	100,000	1,700

These figures indicate that the acreage under sugarcane and coconuts had increased by 20 per cent and 28 per cent respectively,

whereas the area under bananas had decreased by some 42 per cent in the 25 year period. In 1916 a total quantity of 1,651,366 bunches of bananas were exported from the Colony, and the area under this crop must have approximated some 15,000 acres.

In Tables II and III the present status of the agricultural industries of the Colony is clearly depicted. Table II is based on statistics collected in the course of field surveys carried out in 1946 and compiled by Parham²; table III is taken from the Annual Report of the Department of Agric culture for the same year.

TABLE II.
LOCAL CASH AND FOOD CROPS, 1946.

Crops.	Area (A) Cultivated	Area (B) Cropped	Remarks
Cereals cut from grain—			
Millet	80	40	Grown as a supplementary food crop.
Maize	700	450	Principally a dry-zone cash crop.
Rice	26,773	26,773	Growers produced 17,000 tons rice.
Sorghum	20	20	Small areas—not common.
Pulses—			
Beans	320	300	Market garden and household crops.
Soya Bean	10	6	Rarely cultivated by Chinese and Indian growers.
Pigeon pea	2,800	2,200	Cultivated throughout dry areas.
Mung or Urd	300	300	Cultivated in dry areas; generally in short supply.
Others	400	400	Cowpea and other varieties grown for food.
Tuber and Root Crops—			
Potatoes	70	70	Average yield 3½ tons per annum. Total value £5,000.
Sweet potatoes	600	400	Supplementary root crops throughout. No export.
Dalo	12,000	9,000	Staple food grown principally in wet areas.
Tapioca	14,000	10,000	Staple food, grown throughout.
Arrowroot	30	30	Tacca and Maranta grown for starch.
Yams	3,000	2,800	Staple food, principally in dry zone.
Oilseed Crops—			
Groundnuts	1,200	800	Mainly grown for export; some oil (1,500 gal.) expressed locally.
Sesame	40	40	Occasional in small areas (562 gal. expressed locally).
Spices and Condiments—			
Turmeric	30	20	Occasional in small areas; also wild in dry zone.
Caraway	12	12	Occasional in small areas.
Mustard	200	200	Grown throughout year, usually in small plots.
Ginger	80	60	Grown by Fijians and Chinese for local use and export.
Fibres—			
Tobacco	100	80	Casual crop on small holdings in dry zone.
Patwa	30	25	Small areas grown for home use for ropes.
Vegetables—			
Miscellaneous	470	400	Aggregate of small gardens and commercial areas.
Cabbages	80	80	Grown by Chinese and Fijians especially in Beqa Island.
Lettuce	120	120	Widely cultivated in small areas and market gardens.
Tomatoes	160	160	do. do.
Tree and Bush Crops—			
Bananas	2,500	1,700	Cultivated throughout for food; main areas for export.
Lemons	4	4	Small groups of trees cultivated; wild trees abundant.
Oranges	80	80	Small groups of trees cultivated; wild trees common.
Grapefruit	30	30	Small groups of trees cultivated by Europeans, Chinese and Fijians.
Mandarins	120	120	do. do.
Other Citrus	20	20	do. do.
Pineapples	750	400	Commercial areas for canning and for export of fresh fruit.
Industrial Crops—			
Sugar cane	160,000	64,000	Grown under contract by Indians and a few Fijians.
Coconuts	120,000	100,000	Estates and native areas (Fijian production 60 per cent) Total production 28,200 tons copra.

TABLE II.
LOCAL CASH AND FOOD CROPS, 1946.

B.—CROPS PARTIALLY EXPLOITED WITHOUT CULTIVATION.
(Estimated approximate equivalent area 5,310 acres.)

Crops.	Area (A) Cultivated	Area (B) Cropped	Remarks
Sisal.. .. .	3,000	3	Has spread widely in dry areas—fibre occasionally prepared by hand.
Castor oil	600	....	Has spread widely in dry areas—oil expressed locally for home use.
Turmeric	200	5	Has spread widely in dry areas—sold in bazaars.
Coffee	120	20	Cultivated in small groups throughout for home use.
Tea	50	50	Cultivated in plantations.
Cacao	15	....	Abandoned plantings rarely used.
Kapok	25	25	Scattered trees planted by Indians and Fijians, fibre collected has good local sale.
Rubber	800	200	Old plantations partially exploited, 161,879 lb produced in 1946.
Candlenuts	1,000	400	Wild trees throughout Fijian areas—300 tons of nuts supplied for local use and export; 4,030 gals. oil expressed locally.

TABLE II.
LOCAL CASH AND FOOD CROPS, 1946.

C.—PERMANENT MEADOW.

Crops.	Area (A) Cultivated	Area (B) Cropped	Remarks
Permanent meadow ..	acres 125,000	acres	Natural grass areas throughout—used for general cattle grazing.
Permanent pasture. ..	27,000	....	Partially improved areas—used principally for dairying and beef production.
Fodder crops	300	....	Cultivated small plots of Sorghum, Elephant grass, etc.

The areas given in Table II are approximate only.

TABLE III.
PRINCIPAL EXPORT CROPS.

The nett production of export crops is shown in the following table:

PRODUCE EXPORTS, 1946—(TOTAL VALUE £F2,675,371 F.O.B. SUVA (APPROXIMATELY).)

Description	Quantity Exported			Remarks
	Bags	Cases	Tons (approx.)	
Sugar. . . . .	....	....	106,473	Approx. 8,000 tons used locally; value of export £2,111,557.
Copra . . . . .	....	....	16,302	6,077 tons used locally: Export value £379,760. Price F.M.S. from £18 to £25 15s. 0d. per ton.
Coconut oil . . . . .	....	....	1,807	Export value £74,068.
Coconut meal	11,887	....	584	Average £F9 5s. 0d. ton.
Bananas . . . . .	....	86,960	3,492	A Grade 11/5 case f.o.b. Suva; B Grade 10/9½ (247 cases only).
Pineapples (fresh) . . . . .	....	7,003	175	13s. per case f.o.b.
Pineapples (canned) . . . . .	....	....	670	
Citrus fruits . . . . .	....	1,185	30	12s. per case f.o.b. Suva.
Mangoes . . . . .	....	128	3	Consigned to New Zealand.
Avocadoes . . . . .	....	60	1	do. do.
Mixed fruits. . . . .	....	407	15	15s. per case f.o.b. Suva.
Mixed vegetables . . . . .	....	146	2	Consigned to New Zealand.
Watermelons . . . . .	....	....	10	= 2,076 fruits.
Coconuts (fresh)	143	....	6	Husked-trial shipment Canada.
Peanuts	4,401	....	200	Average 9d. per lb f.o.b.
Green ginger	1,729	....	116	Average 3d. per lb f.o.b.
Rice Bran	3,470	....	140	Average £F7 f.o.b. per ton.
Arrowroot	69	....	8	Average 7d. lb f.o.b.
Candlenuts	482	....	40	£10 ton f.o.b.
Candlenut Meal	21	....	1	Trial shipment only.
Dalo . . . . .	....	236	10	£18 ton f.o.b. Suva.
Yams . . . . .	....	46	2	£20 ton f.o.b. Suva.
Hides . . . . .	....	....	....	8,258 hides valued at £9,910.

Increased prices in 1947 for the main export crops and a greatly increased production of copra, coconut oil, meal and subsidiary crops brought the total value of agricultural exports to £F4,424,809 f.o.b. Suva.

Although there has been little change in the agricultural export crops of Fiji during the past thirty years, a major development of considerable significance to the future progress of the Colony and one that has a direct bearing on agricultural policy, has insinuated itself into the scheme of things. This new development which is now fully appreciated in administrative circles may be defined as the decline of large plantation agriculture and the evolution of a small peasant farmer class.

Reference has already been made to plantation practice as it existed in the first few years of the present century. To recapitulate, the main crops sugar, bananas and copra were produced on comparatively large holdings of freehold or Fijian leased land by European owners or managers for European owners. Labour was first obtained from local Fijian and Solomon Island sources, but latterly from India as indentured labour. For several years the whole of the sugar and banana crops were produced in this manner and in 1900 with a copra production of 20,000 tons it was estimated that only 4,000 was cut by Fijians from the coconut groves.

Several obvious factors have contributed to the decline in plantation practice which may be summarized as follows:—

(1) Uneconomic labour conditions which have made it impossible to compete on the world markets with such crops as tea, rubber, spices and vegetable fibres.

(2) Crop pests and diseases in such crops as bananas, coffee, cacao.

(3) Growing competition of annual oil seed crop, whale oil, palm oil with copra, and in general, instability of price for this and other plantation crops including sugar.

(4) With particular reference to bananas, the prohibitive duty of 8s. 4d. per cental imposed by Australia in 1919 as a safeguard to her own developing banana industry.

(5) The scarcity of suitable land in sufficient area to make plantation agriculture an economic proposition.

(6) The increasing population of East Indians with lower standards of living and a gathering pressure on available land;

(7) The paramount consideration of the Government under the Deed of Cession to govern the country in the interests of the Fijian population and preserve their lands from exploitation;

(8) A combination of relevant circumstances as depicted above.

Factors 1 to 4 require little further explanation as they are common in varying degree in other parts of the tropics where capitalistic exploitation has had its day, or where export duties or other foreign Governmental devices have limited the flow of goods. It is important to emphasize that to some extent Fiji has suffered to a greater degree than most other countries due to its unfavourable geographical position for the marketing of its products and the unavailability of cheap and efficient labour during a period when many other tropical countries were establishing a sound position in tropical plantation agriculture.

Fiji is far distant from the chief world markets and high freight charges have added their burden to marketing costs. Our nearest neighbour, New Zealand, takes as much of our produce as her limited population requires, but the Australian market is virtually closed to our primary products. The main bulk of sugar and all the copra are sold on the European market.

Factors 5 to 7 require a little further explanation to define more clearly their implications in the decline of plantation practice.

Practically the whole of the first class land of the Colony is devoted to sugarcane cultivation and dairying, and considerable areas have been leased for cattle raising: the distribution of the land for agricultural purposes is depicted in Table II. The need for reserving adequate land areas for the Fijian people and the growing pressure on available land for the food and cash needs of other races, particularly the Indian population, is of pressing concern.

Although the total land mass of the Colony amounts to some 4,500,000 acres, approximately a half of this area is unsuitable for any form of agriculture, and a further large area should be reserved for afforestation since its exploitation would lead to serious erosion problems. The remainder by land-use planning with adequate safeguard to soil conservation can be utilized as small holdings.

It is still possible to plant up large areas to permanent crops particularly on Viti Levu where the control of *Levuana iridescens* on coconuts is complete; the difficulty lies in the scarcity and inefficiency of labour, and the topography of the country which limits the utilization of mechanical means for clearing, cultivation, etc., and which could be used under more favourable environmental conditions to offset labour difficulties. It is unlikely that any individual would be prepared to risk considerable capital in a plantation venture under the circumstances operating to-day.

The total population of the Colony at the last census³ in 1946 numbered 259,638; of this 120,000 were East Indians which have increased from 20,000 in the early years of the present century. This hardy and hard-working race have flourished in their new environment and, since the abandonment of the indenture system, have contributed largely to the development of the sugar industry, food crops—particularly rice—and other minor cash crops.

The increasing population of Indians has put considerable pressure on available land. With an independent outlook the Indian prefers to own or lease an area which he farms with the assistance of members of his family and, out of season, may work for a limited period as a labour unit.

The Indian is by nature an independent small holder growing his own cash and food crops and with increasing opportunity of cultivating his own land has diminished in importance as a source of plantation labour.

It is true that increasing population and possible land shortage may again make available a labour force of Indians, and at the present time high prices for sugarcane are maintaining a considerable number of unproductive units on many holdings. It is felt, however, that while sufficient land is available the tendency of the Indian will be to adhere to a system of subsistence farming rather than work for cheap labour rates which would be a necessary corollary of falling prices of primary products. By frugality and hard work the Indian peasant is more readily able than most other races to adjust his standard of living.

Apart from the alienation of land that took place prior to Cession and such as has been required for Government purposes the Fijians still retain approximately 90 per cent of the total land area of Fiji which is guaranteed to them under the Deed of Cession. Fijian land cannot be alienated but may be leased by the Native Land Trust Board, which is a statutory board charged with the administration of Fijian lands.

With growing population pressure administrative attention has been directed to the matter of available land for leasing and the adequate provision of suitable areas to meet the present and future needs of the Fijian race.

For this purpose after a consideration of all circumstances the wishes of the Fijian people are being met by the demarcation in all districts of reserves of land for the sole use of the Fijian race.

Although this important and timely measure will facilitate the leasing of areas outside the reserves and place the leasing of Fijian lands on a firmer administrative basis, it will limit the areas available for exploitation and put pressure on the Fijians

to cultivate their own land which in the essence of their social system will be on a communal basis.

The first great change from large estate practice to smaller holdings took place in the sugarcane industry which had come completely under the control of the Colonial Sugar Refining Company.

With the close of the indenture system Indian labour employed on estates preferred to seek opportunities as independent farmers rather than continue to work as labour. Land was freely available and other forms of agriculture such as cotton, maize, rice and peanut cultivation were assuming importance.

With considerable wisdom the Colonial Sugar Refining Company decided to cut up their areas into small farms for leasing to tenant cane farmers under terms and conditions laid down in agreements mutually satisfactory to the Company and the peasant lease holder.

In order to maintain efficiency in the industry the terms of the agreement included provision for the system of farming to be adopted, and the right was reserved to the Company to evict a tenant who failed to observe the conditions of the agreement.

Apart from the production of tenant farmers of the Company, other independent farmers on suitable cane soil could contract to supply the Company with sugarcane.

By this means the Colonial Sugar Refining Company handed over the production of sugarcane to tenant and independent small farmers, but under conditions which determined the system of agriculture, the growth of approved sugarcane varieties, the maintenance of fertility and the control of disease. With complete control over milling and transport arrangements the Company is able to maintain full efficiency.

This system has been described by Shepherd⁴ who considers it to be a model of organization and efficiency, and although it can hardly be described as a co-operative venture the elements of co-operation are there. It is an effective combination of capitalistic enterprise and peasant farmer production in an organization which distributes the proceeds in accordance with a formula based on capital investment and the market price of sugar.

As I have already recorded, banana production prior to 1919 was to some extent a plantation business and larger estates were owned and managed by Europeans. Although it is not possible to give the exact areas under this crop and the size of plantations, it is likely that the total area lay between 15,000 to 20,000 acres with some individual holdings as large as 300 acres. Bananas were also cultivated by Fijian small holder communities for sale to European buyers and it is likely that Fijian production amounted to about 60 per cent of this total. The position as far as European plantings were concerned rapidly deteriorated, and by 1922 it was estimated that plantation areas amounted to little more than 1,600 acres, with a production of approximately 62,000 cases.

To-day there are no banana plantations. The industry from the production end is entirely controlled by Fijians, and it is estimated that some 2,500 acres are cultivated to this crop.

The total production of copra in 1921 was estimated as 20,000 tons on an acreage of 78,500. Of this total 65 per cent was produced by Fijians from coconut groves, and 35 per cent by estates. Native productions were approximately 20 per cent of the total at the beginning of the century.

At the present time (1947) the annual tonnage has passed the 30,000 mark on an area of 100,000 acres and the relative percentages of production by estates and Fijians remain approximately the same.

It is believed, however, that this position will not long remain. On many estates palms are past the age of maximum bearing and in view of the uncertainty of the future of the industry, there is little if any replanting being carried out on estates.

The Fijians to whom this crop is of vital importance and with the knowledge that a favourable bulk purchasing scheme will be in operation for nine years are planting up large areas, and it is likely that copra production on relatively large estates will decline over the next 10 years.

Many of the estate holders are old men who suffered considerable losses during the slump of 1930 to 1939; the tendency is to

make the most of the present favourable market with the minimum of expenditure on rehabilitation.

It is believed that if prices fall below £15 a ton it is unlikely that the coconut crop will be operated under large plantation conditions. Labour problems have always been of some concern to plantation owners and it is significant that many of the better run estates have guaranteed their labour requirements by settling Indian families on the estates. In return for a suitable area of land to grow his food crops, his labour and that of his family is available for copra production on a task and bonus basis.

I think I have said sufficient about the main crops of the Colony to make it evident that large scale plantation practice in Fiji has no future. The further development of the Colony lies in small farming practice by the peasant small holder. The diversification of agriculture under such conditions with the inclusion of a wider variety of cash crops in well ordered rotations becomes possible only by the application of the co-operative method of production and marketing and the provision of cheap credit and security of tenure of holdings.

Apart from the material factors which I had mentioned previously as being concerned with the changing agricultural scene there is a more fundamental urge for change which has its roots in the desire for self expression, independence and security. This is not possible to the agricultural labourer, but is the strength of the peasant proprietor.

The Indian peasant farmer is well established both within and without the sugar areas and is conscious of his independence and freedom of action. The Fijian realizes that in order to maintain his position against the other races of the Colony he must make more and more use of the lands which are reserved to him, otherwise those lands which are not required for Fijian food crops will be forced into agricultural production.

It is immaterial whether the development of such land be on a communal basis or by Fijians freed from social services so long as they are not allowed to remain under jungle or weeds.

Co-operation is well understood by the Fijian as it is inherent in his own social system. Since the passing of the Co-operative Ordinance⁵ in 1948, many Fijian groups have become registered as co-operative societies. Very considerable interest has been displayed by the Fijians as a whole in producer and marketing co-operatives, and it is believed that his interest is an expression of his belief that it is by such means that he will be able to develop his lands and meet the competition of the other races of the Colony.

From such consideration as the foregoing and in keeping with the general principles of Colonial policy as laid down by the United Kingdom Government, the local agricultural policy has been developed and enunciated together with a plan of action involving agricultural investigations. Before dealing with the present agricultural policy and agricultural research programme, I propose to give a brief account of the past activities of the Agricultural Department which is charged with the implementation of the new policy.

BRIEF HISTORY OF THE AGRICULTURAL DEPARTMENT AND ITS RESEARCH ACHIEVEMENTS.

Prior to 1905 no scientific investigations were undertaken in the Colony beyond that of the introduction of economic plants and their trial on plantations.

In that year a small Department of Agriculture was created and from what I have previously recorded respecting the agricultural conditions as they existed in the early years of the present century, it was natural that the immediate concern of the Department was with problems of plantation agriculture, particularly the introduction and trial of economic crops suitable to plantation practice, and the control of insect pests and diseases of economic crops.

The Department commenced its activities under a Director with an Entomologist as Assistant. Shortly afterwards chemical, veterinary and mycological divisions were added. Apart from laboratory facilities the Department possessed two agricultural stations of some 110 acres each, situated at Lautoka in the dry zone and at Nasinu in the wet zone. Much later a cotton experi-

mental station was developed at Nacocolevu on the Sigatoka river, and later still in 1930 the Central Experimental Station at Navuso on the Rewa River. Smaller areas at Waimaro, Dobuilevu and the Model Farm, Naduruloulou, were used for demonstration and instructional purposes.

In the first two decades of the Department's activities, work was centred mainly on the development of and problems concerned with plantation agriculture; chiefly coconuts, bananas, sugar, rubber, cotton and pineapples, although much experimental work was undertaken with coffee, tea, cocoa, sisal, native root crops, rice, fodders and grasses. Later still livestock work with dairy cattle, poultry and pigs was undertaken at Nasinu.

Valuable work was performed on these stations, and in particular many important plant introductions were made through the Nasinu Experiment Station and important legislation dealing with plant and animal quarantine, animal improvement, weed control, fruit export, etc., was passed.

With the growth of a peasant farming class and the need of agricultural education and extension work among Fijians, the necessity of broadening the activities of the department became apparent. This led in 1930 to the development of an extension service of qualified agricultural officers, a training scheme on departmental stations to build up a trained subordinate staff, and the creation of demonstration farms.

It would not be possible for me to deal in adequate detail on this occasion with the scientific work of the Department which has now been in existence for a period of 43 years. A brief account of the work carried out on agricultural Stations with particular reference to the more important achievements will suffice in directing attention to the research work of the department prior to the adoption of the present policy.

Nasinu Station.—This agricultural station was opened in 1906 for experimental work on plantation and food crops. During a depression period it was closed in 1921. In 1929 it was again taken over by the Department for the purpose of conserving the valuable plant material consisting of imported and local economic and ornamental trees and plants.

For a period the area under citrus was used for propagation; later the station was used as a citrus centre research and as a livestock farm. The station was handed over to the Department of Education in 1946.

The more important work was carried out during the years 1906-1921, and may be summarized as follows:—

Cacao.—An area of $9\frac{1}{2}$ acres was established to this crop; the planting material was secured from local sources. Studies were made on cultivation methods, weeding, mulching with stable manure, spraying and pruning, and the effectiveness of various plants as temporary and permanent shade.

Particular attention was directed to control measures against the Indian rose beetle (*Adoretus versutus*, Har.) and the economics of production received attention.

Coffee.—Four varieties, Arabian, Liberian, Angola and Robusta were established in $\frac{1}{2}$ -acre blocks and maintained under approved plantation practice. Yields were studied and manurial experiments undertaken to improve yield.

The intention of this work was to study the feasibility of re-establishing coffee as a plantation crop and it appeared likely that success would attend these efforts. However, in 1914, $7\frac{1}{2}$ years after planting, the crop was badly attacked by the fungus (*Hemileia vastatrix*) which in 1884 had wiped out the commercial plantation of the Colony.

Spraying experiments were designed to control this disease using lime sulphur and other fungicides with limited success. All varieties were uniformly attacked and yields were so reduced that commercial possibilities under plantation conditions appeared unlikely until control of the disease could be secured or resistant strains developed.

Rubber: Para Rubber.—About one acre was planted up to this crop from seedlings raised locally from seed imported from Singapore.

It appeared likely at one stage in the agricultural history of the Colony that rubber might become an important plantation crop; low prices and labour costs hindered an extension of this industry. The total

area under rubber in 1920 was 2,640 acres of which 940 acres were "tapped" with a production of 15,338 lb.

At Nasinu observations were made on rates of growth, tapping yields, systems of tapping, and green manure covers.

It was concluded from these experiments that climate and soil were suitable for the production of rubber and yields under good management conditions were in keeping with those recorded for Malaya and the Netherlands East Indies.

The legume *Dolichos hosea* proved a good cover provided it was established before weeds gained control.

Observations were made on other rubbers particularly *Ficus elastica*, *Castilloa elastica*, *Funtumia elastica* and *Guttapercha* (*Palaquium oblongifolia*).

Fibres.—Valuable experimental observations on yield, cultural practices and preparation for the market were conducted on the fibre plants—sisal hemp, Mauritius hemp, Manila hemp and jute.

Sisal and Mauritius hemp showed great promise. Manila hemp suffered severely from "banana disease". Jute did not do so well except on rich soils and retting difficulties were encountered with this fibre.

In 1920 statistical records showed that 330 acres were planted up to sisal hemp.

Bananas.—In view of the importance of this crop and the considerable wastage caused by "Sigatoka" and other diseases and the weevil borer *Cosmopolites sordidus* a great deal of attention was given to investigation on this crop.

Investigations included:—the use of cover crops and mulching for weed control; intercultivation; comparison of planting on ridges and on the flats; appropriate planting distances; effect of depth of planting on health, vigour and yield of plant; and manurial trials.

Other investigations included the study of the life history of the main varieties and the health and vigour of plants grown from suckers removed from plants suffering from Sigatoka disease.

Of considerable interest was the long term manurial experiment which displayed quite clearly that for the Nasinu soils the application of phosphate fertilizer tended to increase the size of the bunch and potash and nitrogen fertilizers increased the total yield. The economic dressing of complete fertilizers was determined for the soil type. Reference was made to the rapid deterioration of unmanured blocks and the maintenance of production by the use of artificial fertilizers in economic dressings.

Of value also was the observation on the better performance of banana plants under a green manure cover of mulch, as against clean weeding or grass-weed cover.

Singularly enough little attempt was made to study the cause of the condition known as Sigatoka disease and in consequence control measures were mainly of an empirical nature.

Some attempt was made to study resistance to disease and a large number of individuals of commercial and other varieties were imported for observation.

In the year 1913 the predaceous beetle *Plaesus javanus* was introduced by Jepson⁶ for the control of the banana weevil *Cosmopolites sordidus*. This beneficial insect has slowly gained control of the weevil which is not now an important limiting factor to banana production.

Root crops, Rice, Maize, Essential Oils, Spices, Green Manure.—Varietal, cultural and manurial studies were made on Fijian root crops, rice and maize. Essential oils were distilled from several plants including lemon grass and vetiver grass and sent overseas for market report and observations were conducted on spice plants.

The choice of Nasinu as an agricultural station was unfortunate in view of the poor quality of the soils, their shallow depth and lack of uniformity for agronomical work. Also these soils are not representative of the great bulk of the wet zone types. The abandonment of this Station despite its record of achievement was a necessity since it could never have served at the present time as a general experimental station for the Wet Zone of the Colony.

The information gained on cultural operations with permanent crops would be of distinct service in the event of any future

development with such crops as cacao, coffee, rubber and spice.

Lautoka Station.—This station which operated from 1906 to 1916 was principally concerned with cotton and sisal. Important work was also undertaken with rice and maize.

This station situated on average dry zone soils two miles from the town of Lautoka in an average rainfall belt of 64 inches with distinct wet and dry seasons, was admirably sited as a characteristic "dry zone" experimental station.

The purpose of the station was concerned with the reviving of the cotton industry and the possibility of the establishment of sisal as an additional "dry zone" crop.

The work on cotton was directed mainly to cultural and varietal studies particularly with Sea Island types with a view to determining the more suitable planting material for dry zone conditions. Of some importance was the long term manurial experiment which clearly indicated that maximum yields were maintained by the use of organic manures such as dung and compost. Little improvement was affected with artificials at economic dressings and soils rapidly deteriorated under cotton without the addition of organic manure.

The work on sisal which was mainly of a cultural nature was very promising and it was shown that good yields were obtained and that it was particularly suitable as a dry zone crop. There is no doubt that under circumstances of economic prices sisal would have become an important dry zone crop of the Colony.

The cotton experimental work at Lautoka which was the first ever carried out in this country formed the basis of the successful breeding studies which were subsequently undertaken at Sigatoka.

Sigatoka Cotton Experimental Station.—On the recommendation of Mr. G. Evans (now Sir Geoffrey) of the Empire Cotton Growing Corporation who made a thorough tour of the Colony in 1924 it was decided to appoint a cotton specialist to the staff of the Department of Agriculture for the primary purpose of raising by plant breeding new and improved types of cotton together with the testing of new varieties and the carrying out of experiments on the cultivation of the crop.

For this purpose a Cotton Experimental Station of some 80 acres was opened up at Nacocolevu on the flats of the Sigatoka river.

The chief objects of the Station were defined as—

- (1) plant breeding and single plant selection work on Sea Island cotton.
- (2) Varietal tests.

On the basis of past experiments with change in market tastes it was decided to test varieties other than Sea Island in order that should the supply of Sea Island exceed the demand and thus cause a glut the Government would be in a position to replace the Sea Island variety of cotton by some other equally remunerative variety.

Single plant selection work on local Sea Island cotton and on New Guinea Kidney cotton (seed from fine plants selected in New Guinea) led to the isolation of desirable types. All selection work was directed to the production of two types (1) a coarse stapled cotton measuring $1\frac{1}{2}$ inch full which might be sold against rough Peruvian; (2) a fine stapled cotton measuring $1\frac{1}{2}$ inches which might be sold against Egyptian.

Varietal studies on Sea Island (and several local hybrids), Meade, Kidney hybrids from New Guinea, Sakel and Tangius clearly demonstrated the superiority of Sea Island and Kidney for the local climate. Yields were high in both cases but Kidney was late in maturing.

Various crosses were tried and successful results were achieved with the New Guinea and Sea Island back cross families. By further selection and variety trials cottons No. 172 of K3 and S5 (single back cross families) and No. 2 of K3 x S2 x S and No. 5 of K3 x S5 x S (second back cross families) displayed the desired characteristics.

Unfortunately market prices and alterations in marketing requirements respecting types did not permit the commercialization of these cottons which were evolved by Anson⁷.

Important cultural experiments including spacing tests, ratooning and manual trials were also carried out with cotton and latterly the station was broadened to include other crops such as tobacco, maize, rice; and rotation studies involving cotton were undertaken.

Permanent plantings included tung oil, citrus and chaulmoogra.

At the present time this station functions as the dry zone experimental station with emphasis on livestock work.

Central Agricultural Station, Naduruloulou.—An account of the work of this station during the period 1928 to 1947 has been published by Parham⁸. It was first established as a general experimental station for the wet zone and later became the centre for botanical work and plant pathological studies with particular reference to banana diseases.

Banana Investigations.—Of considerable importance was the investigation by Parham of the cause and control of Sigatoka disease. As I have already mentioned, the nature of Sigatoka disease was not clearly understood by previous investigators and there is a suggestion in the records of the Department that the Sigatoka condition was identified by earlier investigators with the disease subsequently described as "bunchy top".

Campbell⁹ made investigations on leaf spotting fungi particularly *Cercospora Musae* Mass. but did not identify this organism either as the disease which destroyed the banana plantations in 1913 or as a serious disease of bananas.

In 1933 Blackie¹⁰, from ripening experiments conducted with diseased and clean fruit, and by defoliation experiments on apparently disease-free bananas, came to the conclusion that the premature ripening of fruit (present with Sigatoka disease) was due to extensive leaf destruction.

Ten years of study of banana diseases on the plots at Naduruloulou led to a complete understanding of the part played by *Cercospora musae*; and the complete control of this condition by copper fungicides in properly designed experiments prevented the onset of the symptoms now clearly identified with the general pattern of Sigatoka disease which developed in the untreated controls.

Studies were also made of bunchy-top virus and selections were made of banana strains which showed resistance to this disease.

Other banana experimental work involved the collection and study of 50 banana and plantain varieties (including the West Indies hybrids S19 and I.C.2); cultivation and manurial experiments; the control of banana pests; the economics of disease control; cover cropping.

Coconuts.—Early in 1926 it was decided to undertake work on coconuts with a view to developing improved seed nuts.

Marechal¹¹ made important pollination studies on selected Rotuman, Niu Leka (local dwarf) and Malayan dwarf coconuts and after devising an artificial pollination technique successfully cross pollinated the Malayan dwarf and the Niu Leka.

In the course of his investigations the following conclusions were reached:—

(1) Coconut pollen germinated better in a 25 per cent saccharose solution containing $4\frac{1}{2}$ per cent gelatine.

(2) Clean pollen of a healthy coconut tree stored in a desiccator containing 35 per cent sulphuric acid was found to be viable after 16 days with a germinating power in (1) of 35 to 60 per cent.

(3) Uncontrolled pollination is established by wind as well as by insects especially by bees and a small fly.

(4) Bees should be encouraged on coconut plantations in order to effect higher yields of nuts.

(5) For controlled pollination pollen of a high vitality is required.

(6) Coconuts can be grown in Fiji by means of artificial pollination.

(7) Uncontrolled selfing is possible with Malayan Dwarfs but impossible with Niu Lekas and Rotumans. Controlled selfing is theoretically possible with any coconut variety as long as the interval between the male and the female phase of the same spathe is shorter than 16 days.

(8) The results obtained with cross pollination between Malayan Dwarfs (female) and Niu Lekas (male) was $27\frac{1}{4}$ per cent; between Niu Lekas (female) and Malayan Dwarfs (male) $34\cdot1$ per cent. Between Rotumans (female) and Rotumans (male) 30.9 per cent.

Two acres of these hybrid dwarf palms and one acre of Rotuman coconuts were established at Naduruloulou. Observations have been maintained for a period of six years since the palms first flowered and selections have been made for further propagation.

With the opening of the Principal Agricultural Station at Koronivia in 1947 the station at Naduruloulou was closed.

OTHER IMPORTANT INVESTIGATIONS.

(1) *Control of Insect Pests of Economic Crops.*—The Department of Agriculture is justly proud of its reputation in the field of biological control of insect pests of coconuts. Lever¹² has given a full account of this important work and my colleague the Entomologist will present a paper on this subject at this Congress. It is sufficient for me to record the following successful biological controls:—

(a) The coconut moth *Levuana iridescens* by the Malayan fly *Ptychomyia remota*.

(b) The scale *Aspidiotus destructor* by the lady bird *Crypton athanodiceps*.

(c) The spike borer *Tirathaba trichogramma* by the wasp *Apanteles tirathabae* and the fly *Erycia basifulva*.

(d) The leaf miner *Promecotheca reichei* by the wasp *Pleurotropis parvulus*.

(2) *Soil Investigations.*—Important investigations on the soils of Fiji have been undertaken by Wright, Blackie and Smythe. This subject will be discussed in some detail by my colleague the Soils Chemist who will present a paper at this meeting of the Pacific Science Congress.

(3) *Weed Control.*—The weed Kösters curse (*Chidemia hirta*) has been spectacularly controlled by an insect *Liothrips urichi* introduced by Simmonds¹³ from Trinidad. Two insects *Agromyza lantana* and *Teleonemia lantana* were introduced to control the weed Lantana. The former was introduced by Jepson¹⁴ in 1910 and the latter by Simmonds¹⁵ in 1928. It is considered that little success has been achieved in the biological control of Lantana.

More recently Parham¹⁶ has had marked success on certain species by the use of hormone weed killers; in particular water hyacinth, which causes considerable trouble in drainage channels, can be kept in check by the use of Weedone at a fraction of the cost involved in hand weeding.

Other studies have included the design of copra driers; mould damage to copra and its control; livestock improvement both by breeding and improved nutrition; botanical determinations on weeds, grasses and forest species; general plant pathological inquiries and chemical work on essential oil plants, gums, resins, tannins, plant species suspected of containing poisonous alkaloids and glucosides, and the determination of vitamin C in local fruits and vegetables.

From 1928 the Department of Agriculture became more aware of the urgent need of extension work among small holders and on its own initiative became concerned with the establishment of Fijian farmers, exempted from social duties, and busied itself with the problem of Indian farmers outside the sugarcane areas.

In consequence more attention was paid to work with native food crops, rice and rotation systems on experimental stations and the development of small demonstration farms.

On the main Agricultural Stations student training schemes were instituted for the purpose of providing the necessary subordinate staff which, in the opinion of the department, was essential for extension work among small holders.

During the period 1933 to 1945 work on stations became concerned mainly with the provision of planting material and livestock for distribution and the small extension service was concentrated on work for the Fijian.

Unfortunately work with the Fijians was not correlated with the efforts of other Government departments concerned with Fijian welfare. The absence of a co-ordinated policy gave rise to difficulties and lack of appreciation of the fundamental

value of this work which has since been accepted as policy.

In reviewing the work of the Department of Agriculture which I have briefly recorded above the following criticisms may reasonably be offered.

(1) Prior to 1928 agricultural stations were developed in unsuitable areas on atypical soils.

(2) Due to pressure of routine executive functions continuity of investigation work was interrupted and much of this work was not related to existing agricultural problems.

(3) Most of the field experimental work particularly at Nasinu carried out on atypical farming soils was badly designed and incapable of statistical analysis.

(4) The need for two distinct branches—investigational services and extension services—was not appreciated until within recent years. When this was recognized the attempt to cover both services with existing staff and facilities led to a dissipation of effort and the interruption or neglect of investigational studies.

It is fair to record that the department has always been understaffed and where opportunity had been given to appoint specialist staff for particular problems, such as the cotton breeding studies and the biological control of insect pests in the coconut industry, outstanding results were achieved.

Without a policy which had the sanction of the administration and which was based on the real problems of agriculture it was unlikely, with frequent changes in the directorate, that continuity and co-ordination could be effected.

It is reasonable also to contend that within recent years the department was fully alive to the changing circumstances of agriculture and with its limited staff did much to meet the new conditions. That it was fully alive to the problems requiring investigation is borne out in the complete acceptance by Professor Shephard of the programme of investigation prepared by the Research Committee of the department.

THE AGRICULTURAL PROBLEMS OF THE COLONY.

In the previous sections of this paper I have discussed the changing agricultural circumstances and the work of the agricultural department before re-organization. It was necessary to deal with this matter in some detail in order that the present policy—which I shall discuss subsequently—may be fully appreciated.

It has been shown that the future of the Colony is concerned with the activities of small holders who have increased in numbers during the past 20 years; and therefore the main problems are bound up with small holder production.

European enterprise is directed to the milling of sugarcane, the production of about 30 per cent of the copra of the Colony, cattle raising and butterfat production.

The Indian community is concentrated on sugarcane production, rice and minor crops including pulses, maize and peanuts. About 85 per cent of beef cattle are raised on small Indian holdings and ghee for home consumption. Most of the food excepting sharps and flour consumed by Indians is produced locally and in particular the extension of rice cultivation within the past ten years has made the Colony self-sufficient in that commodity.

The Fijians grow all their own food requirements and are concerned with bananas and coconuts as cash crops. Some developments with minor crops including maize, peanuts and potatoes are engaging the attention of certain Fijian co-operative groups.

Agricultural development is scattered and the cultivation of cash crops is confined mainly to the flats of the main rivers or valley pockets and is distributed on the two main islands in patches and not in continuous belts.

Europeans and Indians occupy a total of 533,000 acres of alienated land in addition have leased from the Native Land Trust Board additional areas amounting to 292,000 acres. The alienated land is approximately ten per cent of the total and further sales of Fijian lands are not permitted under the Native Lands Trust Ordinance of 1940 which consolidates previous enactments.

The leasing of Native Lands was granted for a period of 21 years prior to 1940; subject to the demarcation of Fijian reserves Native Lands will in future be leased for a period of 30 years under terms and conditions which will be referred to in the Memorandum of Agricultural Policy.

The competition for good land particularly for sugarcane cultivation by Indians has led to considerable speculation in leases and acceptance of encumbrances far beyond the capacity of the soil to give economic returns under good farming techniques.

Any effective policy and action under such policy must take into consideration several basic problems and the outlook of the Department of Agriculture must be directed both in its extension and research activities to work which has a direct bearing on the practical needs of the farming community.

Those present day problems may be stated as follows:—

(a) First and foremost improvements in agriculture cannot be effected under present conditions until security of tenure under appropriate terms and conditions forms the basis of land holding. This problem is fundamental and until it is solved together with such weighty matters as rural credit, compensation for improvements, controlled land utilization and landlord-tenant relationships, progress will be hampered. These are matters of particular concern to the Indian population of the Colony.

(b) The need for improved nutrition both livestock and human demands greater attention to the diversification of food crops, the study of grassland management, forage grasses and legumes, and the further development of animal industries.

(c) Cash crops are limited in number and more attention must be given to the diversification of such crops and the expansion of existing plantings. By planned rotations of annual crops and small permanent plantings of orchard crops on a zonal basis the overall agricultural economy can be steadily improved. Fiji lends itself admirably to such a pattern of development and present tendencies along these lines including co-operative movements should be patiently developed and intelligently stimulated.

(d) Land settlement has been haphazard and many settlers have taken up land for cropping and grazing without due regard to its inherent worth. Soil deterioration though not extensive is apparent in several closely settled areas and will continue to extend unless attention is given to the fundamentals of land management. Land settlement should be planned on the basis of soil survey and conservation principles enforced by the Native Land Trust Board.

(e) Fijians still practice shifting cultivation which is a good system when there is a sufficiency of land. The stabilization of Fijian agriculture on a planned rotation of crops is a pressing problem.

(f) The uncontrolled grazing of livestock has led to serious deterioration of land in the dry zone of the Colony and weed encroachment is a growing menace. The controlled grazing of stock on large areas and their incorporation with arable farming, on small areas, in a system of alternate husbandry, are pressing matters requiring urgent attention.

The rotation of grass with arable crops and the wedding of livestock with crops is the answer to fertility maintenance wherever it can be efficiently practiced.

AGRICULTURAL POLICY.

In 1944 the Government of Fiji invited Professor Shephard of the Tropical School of Agriculture, Trinidad, to examine agricultural conditions in the Colony and advise on policy. Later, in 1945, Professor Pater-son and Dr. Dodds from the same institution visited the Colony for the specific purpose of advising on the organization of the Department of Agriculture and its effective operation.

The Reports¹⁷ of these investigators were published as Council Papers and were considered by a special Committee¹⁸ set up by the Governor. On the basis of these inquiries together with other considerations a Memorandum on Agricultural Policy¹⁹ was prepared by the Director of Agriculture and in this form was adopted by Legislative Council²⁰ in February, 1946.

STATEMENT OF POLICY AND ACTION OFFICIALLY ADOPTED FOR DEPARTMENT OF AGRICULTURE.

PART I—POLICY.

OBJECT OF AGRICULTURAL DEVELOPMENT.

1. The ultimate goal of any plan for the development of agriculture throughout the Colony is the attainment of a progressively higher standard of living by the people of the Colony.

PLAN OF DEVELOPMENT.

2. To achieve this object such a plan must provide for—

(a) the preservation of the land and other natural resources; in particular the conservation and improvement of soil fertility.

(b) The improvement and encouragement of food crops and livestock to secure the optimum nutrition of the people.

(c) The efficient production of raw materials for export and for local secondary industries.

FUNCTION OF AGRICULTURAL DEPARTMENT.

3. It is the function of the Department of Agriculture to further such a policy and the Department should be so organized and equipped both as regards men and materials that it can make an effective contribution thereto.

AGRICULTURAL DEPARTMENT TO CARRY OUT INVESTIGATIONAL PROGRAMME.

4. To enable the Department to play its role as indicated in paragraph 3 the Department must be in a position to—

(a) Undertake an experimental and investigational programme including soil reconnaissance, such programme to be limited to the acquisition of facts necessary to the efficient conduct of practical instruction in agriculture and of extension work amongst farmers.

(b) With the assistance of the knowledge and experience gained through (a), to promote improved systems of land usage and the more efficient production of crops and livestock through the instruction and education of the farming public, the provision of improved types of planting materials and livestock, and the application of protective measures against pests and diseases.

INVESTIGATION AND FIELD WORK TO BE CO-ORDINATED BUT SEPARATE.

5. The two main activities of the Department as expressed in paragraph 4 must be maintained as separate branches of the Department and at the same time be closely co-ordinated by a competent administrative staff.

LIMITS OF EXPERIMENTAL WORK.

6. The experimental and investigational programme should be limited to work on practical problems of immediate importance. Fundamental work on long range problems is outside the scope of the Department's activities.

LAND TENURES.

7. The management of Crown Land should provide for—

- (a) security of tenure by the tenant such as to encourage good farming; and
- (b) the maintenance and increase of the productive capacity of the land.

PART 2—ACTION PROPOSED.

A programme of action to implement the policy outlined in Part 1 of this Memorandum is proposed.

PRINCIPAL AGRICULTURAL STATION.

8. The establishment of a Principal Agricultural Station in the wet zone of Viti Levu, within easy reach of Suva, covering an area of 500 to 800 acres and embracing the principal arable soil types of the zone and a proportion of hill land.

9. The establishment at the Principal Agricultural Station of the biological laboratories of the Department.

10. The establishment of an agricultural station in the dry zone of Viti Levu within easy access of Lautoka covering 250 to 300 acres of the poor to medium soils of the agricultural and pastoral lands of the dry zone and the establishment at this station of the Headquarters of the Western Viti Levu staff.

VANUA LEVU STATION.

11. The establishment of an agricultural station on Vanua Levu within easy reach of Labasa, covering an area of 100 to 150 acres to be used mainly as a stock, seed, and demonstration farm.

EXISTING STATIONS.

12. The maintenance of the existing station at Sigatoka as a stock, seed, and demonstration farm under the control of the dry zone Agricultural Station.

13. The abandonment of all the existing agricultural stations subject to:

(a) The maintenance of the Sigatoka Station as indicated in para. 12;.

(b) The maintenance of the existing nurseries and plantations at the present Central Agricultural Station at Naduruloulou if incorporation with the new principal station proposed in para. 8 is possible.

(c) The maintenance of the sub-station at Dobuilevu, Ra, as a district farm.

SOIL SURVEY.

14. The carrying out of a soils reconnaissance survey of the Colony in order to establish the extent, distribution and characteristics of the principal soil type.

FIELD EXTENSION WORK.

15. The Department of Agriculture—

(a) to undertake a comprehensive programme of extension work and in particular to undertake the co-operative demonstration of improved practices on the farms of progressive farmers;

(b) to establish two small demonstration farms in areas not served by the agricultural stations;

(c) to make extended use of the *Agricultural Journal*, leaflets, and articles to the press; and

(d) the appointment of a Weeds Inspector to have a similar status to that of the Produce Inspector as recommended by the Noxious Weeds Committee in Council Paper No. 35 of 1945.

AGRICULTURAL EDUCATION.

16. The appointment of an Agricultural Officer whose duties will be to give instruction to the students of the Teachers' Training College and the subordinate staff of the Department, and the early development at the Principal Agricultural Station of a Farm Institute.

MARKETING.

17. The appointment of a Marketing Officer whose duties will be—

(a) to promote the marketing of small-holders' produce;

(b) to encourage the development of co-operative marketing;

(c) to explore possible new markets for established or potential agricultural industries.

CO-OPERATION WITH AGRICULTURAL INDUSTRY.

18. The establishment of a standing advisory committee on agriculture which would be representative of the major agricultural industries of the Colony, in order that the direction of the work of the Department of Agriculture should be co-ordinated with the agricultural and general development of the Colony.

WESTERN PACIFIC.

19. The services of the agricultural administrative and specialist officers listed under Subhead 1 of Appendix II to this memorandum to be made available to the Western Pacific High Commission Territories for advice and assistance subject to the Western Pacific High Commission Territories bearing two-fifths of the cost of salaries, travelling expenses, pensions and other charges.

LAND TENURE.

20. The application of the following principles and procedures in the leasing of Crown Land for agricultural purposes—

(a) the maintenance of control over dealings in leases, including the encumbrance of leases;

(b) the adoption of a 30-year term for leases with provision that the lessee will normally be granted an extension for a further period of 15 years at the end of every 15th year on the same conditions: provided there has been no breach of the covenant of the lease and provided further that renewal may be refused if the land is require by Government;

(c) the reassessment of rental at the end of every 15th year of a 30 year lease; provided that there shall be no reassessment during the initial period of 30 years;

(d) the termination of any lease whenever the lease conditions are not observed;

(e) in the case of refusal to extend a lease, the lessee to be paid compensation for all unexhausted improvements on or to the land less the value of dilapidations: provided that the prior and written consent of the landlord shall have been obtained for permanent or long term improvements such as dwellings and farm buildings of substantial construction, wells, fences, drainage and irrigation systems, anti-erosion structures;

(f) where the assessed value of dilapidations exceeds the assessed value of unexhausted improvements on or to the land at the date of expiry the outgoing lessee to be liable for payment of the difference;

(g) on the death of a lessee the lease to pass to the lessee's estate.

In view of the proceeding discussion it is not necessary to comment on this policy except to record that the Native Land Trust Board has accepted in principle the proposal in the Memorandum concerned with the leasing of Crown Land. When Fijian Reserves are finally demarcated tenure of Fijian land will be in accord with these same principles.

OUTLINE OF INVESTIGATIONAL WORK.

In accordance with approved policy (4 (a) and (b) of the Memorandum) the Department of Agriculture is directed to carry out an investigational programme.

Prior to the inquiries by Professor Shephard a programme of work was prepared by a Committee of the department under the Chairmanship of the writer and this was subsequently completely adopted by Professor Shephard and Professor Paterson and is quoted verbatim as Appendix VII in the Shephard Report¹⁷.

From experience and a consideration of problems and conditions it is believed that the major questions which require answers in terms of agricultural investigation are as set out below.

(1) What is the best mixed farming system for the Indian or Fijian peasant farmer raising most of his family's requirements in protective foods and some or most of his staple foods:

- (a) with cane as the principal cash crop?
- (b) with bananas as the principal cash crop?
- (c) with rice, maize, root crops, vegetables and/or other minor crops as cash crops?
- (d) with coconuts and/or cocoa as the principal cash crop?

(2) What improvements can be effected in animal and pasture management including fodder crops for the dairy and stock farmer?

(3) What improvements can be effected in the market garden industry with a view to the extension of local and export trade?

(4) What improvements can be effected in coconut plantation practice and in the preparation and curing of copra?

(5) By the introduction and study of new crops can the economic basis of local farming be widened to provide greater security of cash income?

In the final analysis the department recognized that all agricultural operations resolve themselves in practice to the provision of a sound balanced nutrition for the farmer and his family and cash to maintain a balanced standard of living. Accordingly the economics of farm management and production are the yard stick against which all farming efforts are ultimately measured. Therefore all experimental work on the "Unit Farm" must be finally assessed in terms of economies.

A scheme of agricultural experimental work was drawn up in detail and for the purpose of this paper may be summarized under the following headings.

(1) *Field Experimental Work* (Agricultural).—Zonal and intrazonal rotation layouts, fertilizer, tillage and cultivation methods.

Plantation Crops.—Coconuts, Citrus, other fruit crops, Cocoa, Coffee, Tea.

Field Crops.—Sugar, Bananas, Rice, Vegetables, Maize, Tobacco.

Experimental unit farm to be included on zonal stations.

(2) *Soil Conservation—Fertility and Management*.—Soil surveys, erosion control, fertility studies.

(3) *Plant Research*.—Laboratory and field studies in the domain of Economic Botany, Entomology and Plant Pathology—plant protection services.

(4) *Animal Health and Husbandry*.—A comprehensive scheme of investigation was set out under the following sub-headings.

- (a) Pastures and pasture management;
- (b) breeding and management of livestock;
- (c) diseases of farm animals;
- (d) nutrition of farm animals.

(5) *Processing and Preparation of Farm Products and By-Products*.—A scheme of investigation for the chemical division pertaining to industries directly or indirectly concerned with agriculture.

It is appreciated that any scheme of investigation must be subject to periodic revision. Results obtained in the early stages of investigation or changes in trade conditions and market demand may require major attention to be given to questions to which only minor importance had been attached in the original programme.

RE-ORGANIZATION OF THE DEPARTMENT.

In terms of the Memorandum on Agricultural Policy and with particular reference to Part 2 (dealing with approved action) the following main points of re-organization are recorded in summary form.

(1) The department has been considerably enlarged and includes 33 qualified professional and technical officers, 48 trained subordinate staff and 20 clerical officers.

(2) It is divided into three main branches: (a) Administration; (b) Research and Station Services; (c) Extension Services.

(a) *Administration*.—This includes a Director and a Deputy Director with supporting clerical staff.

(b) *Research and Station Services*.—Comprises the laboratories and experimental stations of the department which are organized as follows:—

(i) *Chemistry*.—Three Chemists covering the fields of agricultural chemistry, soil science and soil survey, and general chemistry are stationed with supporting subordinate staff in a well equipped laboratory at Headquarters in Suva.

(ii) *Entomology*.—One Entomologist with supporting subordinate staff and laboratory is stationed at Naduruloulou. He will move to the experimental station at Koronivia when the new laboratory is constructed.

(iii) *Economic Botany*.—One Economic Botanist with supporting subordinate staff and laboratory is stationed at Naduruloulou. He will move to the experimental station at Koronivia when the new laboratory is constructed.

(iv) *Animal Husbandry*.—One Animal Husbandry Officer is resident on the Sigatoka Agricultural Station where livestock work is the principal concern.

(v) *Agronomy*.—One Agronomist with a Farm Manager and supporting station staff is resident on and in charge of the Principal Agricultural Station, Koronivia.

(c) *Extension Services*.—This service is divided into two divisions.

(i) *Veterinary and Fisheries Division*.—This includes a Senior Veterinary Officer, two Veterinary Officers, a Senior Livestock Officer, a Senior Meat Inspector, five livestock officers and a supporting subordinate staff. The Senior Veterinary Officer is stationed at the headquarters of the Department in Suva but the rest of the staff are related to the main administrative districts of the Colony.

(ii) *Field Agriculture and Produce Inspection Division*.—This comprises a Senior Agricultural Officer, three Agricultural Officers, one Registrar of Co-operative Societies, one Marketing Officer, one Produce Inspector, one Senior Agricultural Assistant and six Agricultural Assistants, 20 supporting subordinate staff. The three Agricultural Officers with supporting staff are stationed in the districts.

The Department will, in due course, possess three agricultural stations and two district farms. The Dry-Zone Station of approximately 300 acres is fully developed and in operation; the Principal Experiment Station of 410 acres is being rapidly developed and land had already been prepared for important experimental work in the 1948-1949 season. A demonstration farm at Dobuilevu of 20 acres, the Model small peasant holding at Naduruloulou and the

economic and ornamental plant area at Nasinu have been in operation for a number of years.

By agreement with the British Solomon Islands Protectorate the Gilbert and Ellice Islands Colony and the Kingdom of Tonga the responsibility of the Directorate and certain technical officers will also cover these territories. During 1948 the Entomologist has made studies in the Solomons in connexion with coconut pests, and the Senior Veterinary Officer, after a visit to Tonga, has advised on livestock matters.

More recent developments have included an approach to the United Kingdom for funds from the Research Grant of the Colonial Development Fund to make additional appointments of a Plant Pathologist, a Systematic Botanist and a Biochemist to strengthen the existing biological and chemical divisions; and approval has been secured to place on the estimates for 1949 a sum of £5,000 to procure agricultural tractors, drainage machinery and implements for demonstration purposes in the Colony. Such machinery will be additional to that already possessed by the Department of Agriculture for work on Stations.

PROGRESS WITH EXPERIMENTAL WORK.

Although difficulties have been experienced in obtaining suitably qualified staff, material and equipment for laboratories and stations some progress has already been achieved in current investigations.

The work in operation is briefly summarized below.

(1) *Field Experimental Work—Agricultural*.—Important information has already been secured in past work on crop rotation, fertilizer studies, tillage, cultivation methods and small holder agriculture and extension services are in a position to advise.

Manurial Trials on grasslands are in operation in several localities and on experimental stations, including the testing of the manurial value of local phosphate deposits.

Rice Manurial Trials have been completed and rice variety trials are being continued.

Introduced and established fodder grasses and legumes are under trial on departmental stations.

The Mauritius system for the manufacture of compost is under examination on experimental stations.

Important crop work is continuing on native food crops, bananas, copra, pine-apples and crop rotations suitable to peasant agriculture: this work is being conducted in both the dry and wet zones.

(2) *Soil Conservation Fertility and Management*.—Fertility studies involving ley farming are being conducted on the Sigatoka Experimental Station and manurial trials in addition to those already accomplished will be conducted on both stations with the main cash and food crops. Demonstration of soil conservation methods suitable to the climatic region have been in operation for several years; within the last two years this work, together with fertility maintenance using farm manure, has been extended to include co-operation with peasant farmers. The Soil Survey, as has already been stated, is in operation and long term soil studies and other agricultural chemical problems are engaging the attention of the Chemical division.

(3) *Plant Research*.—The Economic Botanist is engaged principally on (a) variety trials with plants—grasses, legumes, cash and food crops; (b) plant identification; (c) weed control studies; (d) vegetation studies on grasses (ecological), pastures, weeds; (e) plant protection services (with Entomologist) and disease investigations of bananas and rice.

The Entomologist apart from routine pest control work, is engaged on studies concerned with (a) the newer insecticides against pests of a wide range of economic crops; (b) specific studies on army and cut worms, rice yellows (*Sogata*), the stick insect on coconuts and several coconut pests of the Solomon Islands.

(4) *Animal Health and Husbandry*.—Nutrition, herd management and pasture management studies are in operation on the Sigatoka Experimental Station. Considerable progress has already been achieved here and also by co-operative work with local dairy farmers.

Studies in grassland establishment involving tropical legumes and grasses, soilage, ensilage preparation, the economics of live-stock raising, pig production and management, poultry raising, are important topics of investigation on the Sigatoka Experimental Station. Considerable progress is reported in the Annual Report for 1947.

(5) *Processing and Preparation of Farm Products*.—Work in this direction is contemplated in 1949.

LONG RANGE AGRICULTURAL RESEARCH WORK.

The Policy Statement at paragraph 5 of the Memorandum defines the limits of experimental work to be undertaken by the Department of Agriculture. The experimental and investigational programmes must be limited to work on practical problems of immediate importance.

There are many problems in the South Pacific region which require fundamental investigation and are of a nature normally undertaken by research institutes or universities.

There are no research institutes or universities in the islands of the South Pacific and in consequence long range fundamental studies which are basic to applied agriculture are neglected.

It is wise to limit the activities of a small department to applied investigations of immediate economic importance but it is impossible by such means to build up a body of factual information on the basic sciences which serve agriculture unless there is available a group of trained scientists with opportunity and scope to study fundamental matters of botany, zoology, geology, soil science, ecology, phyto-pathology, plant breeding—to mention but a few.

Moreover such work must be studied on the spot in a properly equipped institution. It cannot be undertaken with complete success or with continuity of effort by a foreign institution working in a different environment. Work performed by other tropical institutes of scientific research is applicable to some extent but fundamental studies must be conducted on the spot.

Such thoughts have been ever present in the minds of the agricultural scientists of Fiji who while recognizing that there are limits to the expenditure on scientific work by a small administration have been conscious of the need of a balanced institution engaged on fundamental scientific work.

The records of the Department of Agriculture show that as early as 1931 opinions were expressed on the need for an agricultural research institute centred in Fiji and financed by interested Governments.

In 1945 and 1946 following discussions with the author of this paper, Sir Theodore Rigg of the Cawthorn Institute and Dr. E. Marsden, F.R.S., former Secretary of Scientific and Industrial Research, New Zealand, put forward concrete proposals for the establishment of an agricultural research centre in Fiji.

The creation of the South Pacific Commission²¹ with a programme of agricultural work which bears a striking resemblance to that laid down for the Department of Agriculture, Fiji in 1946 is viewed with very great interest by the peoples of the Pacific. It may well be that this broader conception will answer many of the difficulties that have faced the scientists of this region in their endeavours to advance scientific knowledge. It is sincerely hoped that apart from co-ordinating the work of existing institutions full pressure will be directed to the accumulation of basic knowledge by competent scientists in the direct employ of the Commission. It is along these lines that real advances will be made and fundamental information acquired.

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FORESTRY PROBLEMS OF THE SOUTH PACIFIC

BY COLIN MARSHALL

In this paper, read before the Seventh Pacific Science Congress, are discussed the problems confronting forestry in the South Pacific Islands. In none of the islands has the need for or indeed the full scope and nature of Forestry been recognized by the community, which are like all pioneer communities, engaged in reaping the harvest found on the land, oblivious of the duty of providing natural resources for their descendants. The first forest officer was appointed to Fiji in 1938 and to New Caledonia in 1947. In other islands forestry has yet to be started.

1. In the South Pacific the major problem confronting forestry is ecological, using that word in its widest sense to mean the science of association of living things, and their mutual reactions. Forestry covers such a wide field that it impinges on almost all aspects of a nation's economy and no forester who confines his activities solely to the growing and harvesting of trees, is giving to mankind the full benefit of his knowledge and service. We foresters have been trained to take a detached altruistic view of our forest estate. We plant so that someone, of what race or nation we know not, may reap in one hundred years, and may have a better life. We tend and plant tree crops on steep hill-sides so that the agriculturalists in the plains may benefit. We have been inclined to be diffident, retiring, shy backwoodsmen, tongue-tied in the presence of smooth-tongued town political orators. The public treats "scientists" with a certain amount of respect, but rarely considers foresters as "scientists". Until the Governments of the world ask for, accept and act upon recommendations of "land utilization scientists" in other words of foresters and agriculturalists in respect of the ecological consequences of their political schemes, we may continue to expect the available fertile land surface of the world to continue to decrease. It would not be exaggerating to say that 50 per cent of the total possible productive capacity of the land mass of the world has been destroyed by man and that more is being destroyed every day by faulty land management.

2. There is no room in this paper to consider the examples of man's astonishing ability to overcrop and overgraze a country which he persistently denudes of all tree growth, but we can glance back through history to the destruction of the forests, erosion of the soil and consequent silting and flooding of the rivers of Mesopotamia, of the Nile Valley, of the Punjab, of the Ganges Valley, of the Yellow River—China's sorrow, and in recent times of the Missouri—the Great Muddy. The Mississippi—Missouri river system has been so heavily damaged by man during the last 200 years it will take many decades before the energy and wealth of the American people can restore it to full productivity.

The Americans with the grim object lesson of the "Dust Bowl" confronting them have learnt wisdom. Many individuals in the rest of the world realize the urgency of the problem and the need for immediate action, but the mass of the people and of the governing bodies of the nations do not, or if they do, they shrug the matter aside as being too big to be faced.

3. We have here in the South Pacific, areas of land which have been shielded from the dangers of the Euro-Asiatic way of life by physical isolation up to the year 1800. We have already in 150 years caused grave damage, and we are taking practically no steps to prevent further damage and destruction of these fertile lands. The rate of destruction is increasing yearly, and yet economic and social factors are held to be insuperable obstacles to drastic remedial measures. In this paper, though the arguments apply to all Southern Pacific areas, illustrations are drawn from areas known to the writer, and the special problems of the Fiji Islands group are given pride of place. The dangers and difficulties are recognized by the Government of Fiji.

4. The islands of the South West Pacific appear to have been in the distant past clothed with a climax vegetation in which the Fiji Kauri (*Agathis Vitiensis*) was the dominant species in the upper canopy, with shade bearing species, like Damanu (*Callophyllum* spp.) being noticeable in the under storey. The gradual infiltration of illiterate agricultural tribes resulted in shifting cultivation and the spread of secondary forest of bamboo or of tree species with a high proportion of light demanding species such as Kauvula (*Endospermum macrophyllum*) and Kaudamu (*Myrtica castanefolia*). Erosion was not a grave danger because the inhabitants had no reason to fire the areas of secondary growth. It is clear, however, that erosion did occur but that this erosion has not been severe or continuous over a very long period. The mouth of the Sigatoka River in Fiji has evidently been changed by the sand brought down by the erosion of the hill lands in the river basin. This basin now consists almost entirely of bare hill slopes covered with coarse grass. There is, to the West of the river mouth, an area of approximately a square mile of sand dunes which are advancing inland. The obvious recent origin of these dunes points to the comparative late settlement of the island and consequent erosion of the hills. It is noticeable that nokonoko (*Casuarina equisetifolia*) propagates itself on these bare slopes. In 1881 John Horne, the visiting Director of Woods and Forests from Mauritius, wrote that disastrous fires were then raging in these Casuarina forests.

5. With the advent of European traders, the Sandalwood tree became the chief source of wealth and was ruthlessly exploited, soon becoming extinct. Other timbers were cut too, and though they did not produce such fabulous profits, it is clear that the Kauri forests near the coast and the rivers were "creamed" for the best of the crop. Horne notes in his *Year in Fiji*, that "European sawyers have played sad havoc amongst them, and large trees were only found in the more inaccessible parts of the mountains", and that "It will be incumbent on the Government of Fiji to keep a considerable area of land under timber and to plant extensively on land at present

unwooded", and further that a "Forestry Department should increase in importance along with the Colony". Unfortunately no action was taken to implement Horne's recommendations.

6. Then came the substitution of a cash economy for primitive village self-sufficiency. Specialized crop cultivation was introduced, in place of the former mixed shifting cultivation with long term tree fallow. People tended to become concentrated into large centres and in the market gardens surrounding these towns practiced more and more intensive cropping of the soil. In the Suva area of low steep sided hills, where the underlying mudstone—locally called soapstone—was overlain by two or three feet of soil, erosion was particularly bad, but the people complacently spoke of "the soapstone coming to the surface" and never of "the surface soil being eroded from the land". As an area became unproductive the farmers drove the forest back yet further. Immigrant Indians, coming from a land which has been degraded by centuries of over-cropping did not see anything wrong or strange in erosion and for reasons which will be clear later see no reason to undertake anti-erosion measures.

7. These new immigrants brought new laws and customs to replace the old "tabus", many of which had been evolved over centuries and prevented the denudation of the land. To give but a few examples from other countries. When a death occurs amongst certain savage tribes, the settlement is deserted immediately after the funeral, and in a few years the village site and the cultivated fields revert to forest fallow. In Malaya no village could consider itself safe from raids by pirates if it permitted any sign of the village or of cultivation to be seen from the deep main stream up which the pirates were likely to cruise. Consequently a strip of forest many chains wide was always left untouched along the banks of all navigable streams which remained narrow and deep. When British administration brought freedom from the fear of pirate raids, cultivation extended up to the banks, and, deprived of the protection of the tree roots and other vegetation, the banks fell in, the rivers

became wider and wider, shallows and sand-banks appeared until to-day virtually all rivers in that country are useless as a means of transportation. Floods have increased. Laws have been passed forbidding the clearing of any vegetation along the river banks, but penalties are small. In the old days the automatic penalty for river bank cultivation was capture or death in a pirate raid. It is difficult for the administrators and the public to realize the seriousness of the crime of assisting river bank erosion by thoughtless cultivation and the need for heavy penalties. Many another "tabu" whose penalty was death, maintained the ecological *status quo*. Now that European customs have ousted the native customs, now that specialization in labour is forcing the labourer to practice intensive cropping, the danger of erosion is intensified.

8. Settlers in new lands with seemingly inexhaustible areas of forest usually treat the forest as an enemy. They talk about the "bush" and about "improving" the land by clearing the "bush". When everyone has "improved" his land to the uttermost the climate changes and deserts result. The change in rainfall on the smaller islands brought about by the destruction of tree growth is a problem requiring consideration for on its solution may depend the future of the numerous islets of the South Pacific. It appears that the destruction of tree cover results in a decrease in rainfall. Inhabitants of these islands tell of droughts of six months or more and of seeing rainstorms over the sea and clouds approaching the island only to dissipate when they near the land. It may be that the bare island hills and sandy beaches reflect the sun's heat, which would have been absorbed by the sea or by a tree covered slope. The rain clouds, just about to drop their moisture, would receive these heat radiations as they approach the island, and would be dissipated. In the night the cooling effect of the small land area would not be strong enough to induce precipitation in any mass of damp air before it had been swept on by the current of the trade winds. A theory recently propounded by meteorologists to account for the formation of vortices which become the centres of

hurricanes, states that it is the strong up-draft from hot bare islands that is the nucleus around which such a vortex forms. If this is true that problem acquires a still greater urgency. There is only one solution of this problem, it is for the use of all land to be controlled by the scientific departments concerned.

9. Following the introduction of specialized crops, certain pests appeared. In Fiji rats, introduced by accident, became a pest on the sugar-cane and so the Indian mongoose was introduced to kill the rats. The mongoose has brought the rats under control, but also has destroyed almost all the ground-nesting birds of the islands it has reached. The effect the loss of this bird life has had on the propagation of seeds of certain forest trees and on the control of insect pests cannot be determined. Toads were introduced to eat the insects parasitic on the sugar-cane. They have multiplied to an incredible extent and may be destroying the insects required by trees for cross pollination. In order to control the weed Koster's curse (*Clidemia hirta*) the Department of Agriculture imported an insect *Lichtrips urichi*. As far as we know this insect is not a parasite on any useful plant or tree, but it may become a pest itself. Numerous other parasites on introduced pests will be imported in the future. Their effect on the ecological climax type of forest cover presents yet another forestry problem for which no predeterminable solution exists.

10. By far the most important new ecological factor has been the introduction of herds of grazing animals. To provide grass for their cattle the owners cleared and burnt areas of forest and they fired the tree species colonizing areas of abandoned shifting cultivation in order to encourage grass growth. Within a month of the beginning of the dry season the hills of the dry sides of the islands are blackened and at night the gleam of innumerable fires can be seen from the sea. The case of Fiji is identical with that of the "cogon" lands of Philippine Islands and "lalang" areas of Malaya, areas of coarse grasses, largely non-productive. They are becoming more and more degraded as years go on and yet the cost of re-afforestation—the only possible method

of restoring fertility—is so great that it is beyond practical politics. Fiji has over a million acres of dry hill side. Uncontrolled shifting cultivation is pushing back the forest every year. For reasons which will appear later the natives cannot be prevented from carrying out shifting cultivation, and destroying the forest. Presuming that we wish to plant the bare dry hills with forest trees in 100 years, this will at least mean the planting of some hardy pioneer species over 10,000 acres per year, plus the underplanting of this acreage with some shade-bearing, more exacting species over the 10,000 block planted 20 years ago, plus the underplanting of that second stage crop with the climatic climax type mixed crop. This means work over 30,000 acres per year, or the planting of an average of 300 acres per day of the wet season, in addition to fire protection, the construction of roads, etc. The cost of this scheme would not be far short of half a million pounds per year. That is only part of the extent of the damage to the forests and to the land which should have been kept under forest, during the last 150 years. As this expenditure cannot be contemplated, the only solution is to admit that we will reafforest the hills in 1,000 years at the rate of 10 acres per day on the average or in practice 30 acres per day during the first part of the wet season, as newly planted trees could live through the dry season. Even this modest figure involves expenditure much larger than has ever been contemplated by Government in the past, and must await the solution of the political problems and of the problems detailed below. In the meantime, unless laws are enacted to forbid it, shifting cultivation and burning will have destroyed yet larger areas.

11. Only a very small area of the land of Fiji is owned by the Crown. Excepting for 836 square miles sold to private individuals in the days before British Administration, practically all the land is owned by various Fijian tribes and is never sold but is administered on their behalf by the Native Land Trust Board. The Board refers any decision concerning the leases of land, the licensing of timber felling rights or the reservation of an area for re-afforestation to the native tribe concerned. These tribes are considered to have the right to practice

shifting cultivation on their own lands even if it means the ultimate destruction of the usefulness of their tribal lands. Similarly the holders of large freehold blocks of land can, if they wish to denude their holdings of all tree growth even if it means the silting and flooding of the lower courses of the river. The new Forest Policy now under consideration by Government calls for control of all fellings on all lands.

12. Because all undeveloped land is owned by Fijians, the immigrant Indian—largely Hindu—population can obtain land only on lease and cannot purchase outright. The Indian tenants see no reason why they should guard the precious topsoil by expensive anti-erosion measures. They claim that if they did keep the land “in good heart” and did spend large sums on erosion control their leased areas would become so attractive that the Fijian owners would refuse to renew the lease and would take over the farm themselves. The leased land should be subject to anti-erosion clauses, but the Native Land Trust Board has not the income to provide the staff and certainly not the technically trained staff to do this. We cannot say that justice would be served by forcing the Fijians to sell to immigrant aliens, land that they say will be needed for the natural increase in numbers of their own race.

13. These Hindu and other Indian immigrants have brought to Fiji another problem. They worship the cow and may not kill one. They very often own one or two acres of land and their herd increases to 20 or 30 head. They therefore are compelled to seek free open range grazing which they obtain by firing the abandoned Fijian shifting cultivation “gardens” and the open grass covered hills. The Fijians too want grazing land for their cattle and fire these areas. The more an area is fired, the poorer it becomes and the larger the area which is required to feed the same number of beasts. The effect is cumulative and only extensive patrolling by a mounted forestry field staff, the rounding up of unmarked or straying cattle and the arrest and imprisonment of anyone caught setting fires will slow this damage. It is inevitable that under present political, economic and religious conditions the Hindu owned herds

of cattle will increase until they overgraze all the land, and, as in India itself the animals become just skin and bone, useless for anything. The destruction of the forests of India by overgrazing has been solved only by the imposition of rigidly enforced laws and controls.

14. Fiji has suffered from a shortage of building timbers for many years and imports between one third and two thirds of its requirements of six million super feet per annum. There is a chronic shortage of timber and local merchants would naturally rather import and sell than risk the investment of capital in saw-mills and logging equipment. The imposition of an import tariff would raise the price of the essential imported timber and would enable local prices to rise, a most unpopular result at any time and especially during the present grave housing shortage. The argument has been advanced that as Fiji has a favourable balance of trade with Canada it would be improper to restrict the import of Canadian timber. In pre-war days when the Canadian and American timber industry kept up its volume of production by dumping timber on the Fiji market, it was not an economic proposition to erect a sawmill and commence extensive and expensive logging operations in Fiji. Only when Fiji has an adequate prosperous timber industry, able to pay a sufficient amount in Government fees to cover most of the cost of reafforestation, or better still able to show a surplus, can we expect much advance in forestry in the islands.

15. Coupled with the pre-war low price and the present relative availability of imported timber, has arisen a "buyer's resistance" to local timber. Local species are numerous and widely scattered, as species always are in tropical forests, and only a few are recognised by the builders and townspeople. Hard broadleaved timbers are imported from Australia, not because there are not as good and better hardwoods in our own forests but because local hardwoods are unknown and are often cut up for firewood. If the Department of Forestry had been able to have botanically authenticated specimens of timber tested and if the Department were responsible for

the purchase and storage of all timber used by Government, it would be possible to season these little known timbers properly, then test them in actual buildings to popularize them. Importers of timbers naturally advertise their goods and have convinced the public that the imported mixed coniferous Canadian timber sold here as "Oregon" is superior to Kauri or any local timber and does not need impregnation. All timber is in such demand that local timbers are rarely if ever used seasoned and thus hold a poor reputation for stability.

16. Against this back-ground of economic, political and general land utilization problems we can consider forestry proper. The public, because the title of the head of the Department of Forestry is Conservator, feel that his duty is to conserve the forests by preventing fellings. The areas of land set aside for timber production in perpetuity are labelled "Forest Reserves" which to the public means an area into which no one may enter and in which no timber may be cut. It is not wrong to bring the capital asset of virgin forests into production. Virgin forest is producing nothing, what grows is only replacing what has fallen and decayed. When man removes what he wants from the virgin forest then, and only then, will the forests commence production for world economy. If the forest is not ruthlessly exploited, but is tended properly on sound silvicultural lines the volume of timber available per acre on the maturity of the second crop, will be a very considerable increase on that in the natural forest.

17. Those who are accustomed to the gregarious species of normal temperate forest and who see for the first time the green of lush tropical vegetation, must obtain a false and exaggerated impression, not of the productive ability of tropical forest but of the volume of timber available in normal tropical forest. We can assume that an average stand of first quality tropical forest will produce from 200 to 2,000 cubic feet (hoppus) or 2,400 to 24,000 board feet (hoppus) per acre, or 10 to 150 cubic metres (true) per hectare compared with 5,000 cubic feet, 60,000 board feet per acre, or 450 m³ per hectare of the normal coniferous forests of Europe, and up to

15,000 cubic feet or 180,000 board feet per acre or 1,355 m₃ per hectare in the forests of the Pacific coast of America. This does not mean that the tropical forests will not produce per acre per year a greater sustained yield than forests in areas less climatically favoured. It is essential however that sound forest management and silviculture should be included in the administrative aims of the Pacific Islands and that the public should be informed and kept informed of the aims and achievements of Forestry.

18. The purely technical problems of regeneration of the forests seem to be comparatively simple. In prewar Malaya it was considered essential for the future crop to be seen, established on the ground, before the mother trees were removed. An elaborate and very efficient series of operations spaced at two-yearly intervals insured this. The operations were, "Pole fellings" to remove the lower canopy and less valuable pole species, followed by "Seedling felling (1)" during which large trees of the non-timber and other secondary species were removed, followed by "Cleaning-Girdling (1)" during which all climbers, weeds and regrowth of less desirable species were cut back and at the same time unsaleable secondary species were killed by "frill-girdling" with poison. This was followed sometimes by a "Seedling Felling (2)" or sometimes by a "Final Felling" according to the abundance or absence of regeneration. Lastly a "Cleaning Girdling (2)" removed all unwanted regrowth and all large unsaleable trees. During the Japanese occupation no silvicultural operations were carried out and it appeared at first sight as if the felled areas would contain little regeneration. Cleanings and countings however showed that there was present nearly 60 per cent of what would have been present had the full cycle of operations been carried out.

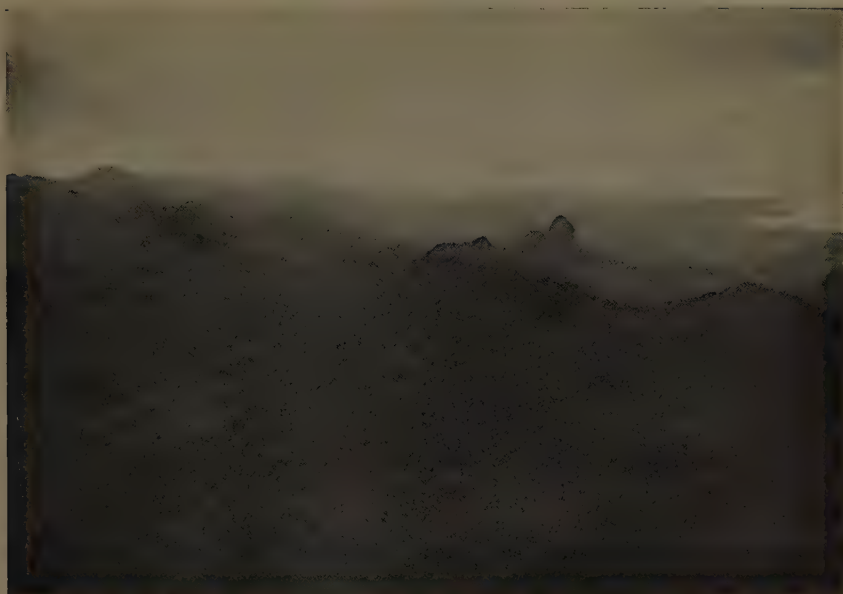
19. From experiments carried out in the Waipoa Forest in New Zealand the seedlings of Kauri seem to be killed off by root competition from the parent tree. This seems to have been confirmed by the figures obtained from 100 per cent countings carried out acre-block by acre-block at Nadarivatu in Fiji in a compartment which had been completely logged without any restric-

tions. Here from 200 to 1,200 trees of recognized useful species between five feet in height and 12 inches in diameter have been found to be present in addition to numerous unrecognized species. It seems that natural tropical forest contains in the small pole stage or dormant seedling or seed stages enough regeneration to replace completely the original forest, provided that the area is not burnt and provided that we assist the attainment of the ecological climax vegetation by cleanings designed to remove climbers, scramblers and fast growing, prolifically seeding, light demanding, secondary forest species when these latter are competing with true high forest species.

20. On the dry side of the islands the reafforestation problem is much more difficult of solution. The fire danger is paramount. It seems probable that the best approach will be to convert the native Fijian tribes from uncontrolled shifting cultivation to a modified Burmese "Taung-Ya" system. Under this the cultivator fells and burns the scrub, and is provided with seedlings in bamboo pots. These he plants at 6ft. x 6ft. or 10ft. x 10ft. spacing mixed with his food crop. When he is ready to abandon the area and move on, the local Forest Guard inspects, and, provided that a reasonable number of seedlings have remained alive, the cultivator is paid at the rate of, say £2 per acre. The "long term bush fallow" called "shifting cultivation" may well become the standard method of reafforestation where there is a heavy demand for land to grow food crops.

21. Though it is realized that indigenous species are normally the best, we are introducing a number of exotics, teak, true mahogany, pines, etc. These pines have brought their own problems, for the soil in these islands does not seem to contain the necessary mycorrhiza. Both cultures and conifer litter have been imported to infect the seed-beds. The introduction of these exotics has however resulted in a much greater public interest in and belief in forestry and the plantations may produce valuable timber in the future.

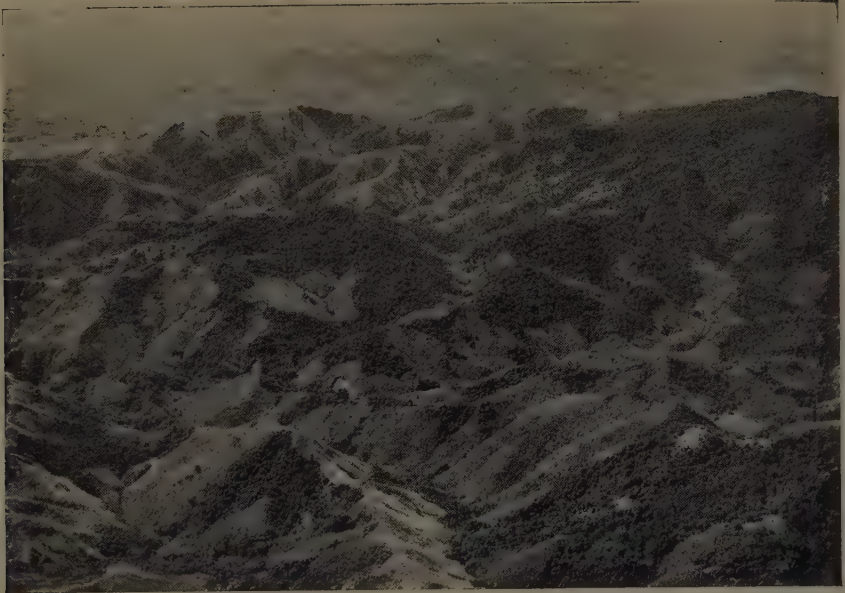
PROGRESS OF DENUDATION



Wet, windward or south-east side of an island. Normal climatic climax type vegetation.



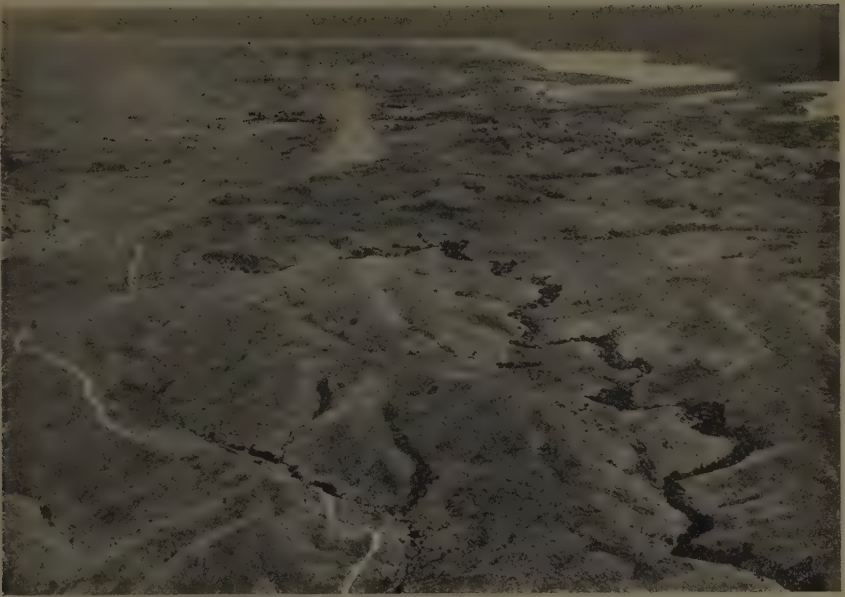
Shifting cultivation "gardens" now abandoned and covered with bamboo. Photo of the wet side of an island. If this was on the dry side, fire would have destroyed a far larger area.



Intermediate Zone between the wet and dry. Abandoned shifting cultivation "gardens" some covered with bamboo growth, others burnt and now covered with reeds and coarse grass.



Dry side conditions. The burnt slopes are covered with reeds used for thatching and house building. An occasional *Casuarina equisetifolia* tree can be noticed as well as burnt areas and the forest remnants in the gullies. Grass is replacing reeds in some areas.



Bare hill slopes covered with reeds which are being displaced by the useless coarse "mission grass" introduced at the beginning of the century. Fires are visible in the background.



Typical dry, lee side, conditions. Most of the soil has been washed off these bare slopes to kill the coral of the shore reef and to form mangrove swamps.

22. *Summary.*—Fiji has an ideal climate for forestry. The steep hill slopes and heavy rain make tree cover most desirable to prevent erosion and climatic changes. There will be an unsatisfied demand for timber in the world markets for many decades. The problems facing Fiji and the Southern Pacific generally are those of a

country in the process of settlement and development. Politics, economics and even religions impinge on forestry and add to its problems. The great need is for the essential nature of "land use planning" to be accepted by the peoples and governments of this area.

LEGISLATION

BANANA BOARD.

A Banana Board has been set up, under the Chairmanship of the Director of Agriculture, for a period of two years from 1st January, 1949. The following are members:

District Commissioner Southern.

Agricultural Officer Southern.

Ratu E. T. Cakobau, M.C.

J. K. Ravai.

A. R. Freeman.

R. W. Spowart.

Secretary: Produce Inspector.

* * *

PRICE OF BANANAS.

An increased price for bananas will be paid at packing stations by licensed buyers as from 23rd March, 1949, as under:—

Viti Levu and Beqa 6s. 6d. per case.

Other areas, Kadavu, Koro, Gau, etc.

5s. 6d. per case.

* * *

ANIMALS' IMPORTATION ORDINANCE.

The Senior Livestock Officer has been appointed Inspector under the above Ordinance.

CO-OPERATIVE SOCIETIES.

The following have registered under the Co-operative Societies Ordinance:—

Vitogo Co-operative Farming and Marketing Society Limited.

Kisan Co-operative Storeholders Society Limited.

* * *

PUBLIC HEALTH ORDINANCE.

The following have been appointed Dairy Inspectors under the above Ordinance:—

C. R. Turbet, Senior Veterinary Officer.

H. T. B. Hall, Veterinary Officer.

K. J. Garnett, Veterinary Officer.

T. P. Gardiner, Senior Livestock Officer.

T. L. Munc, Livestock Officer.

S. O. C. Kerkham, Livestock Officer.

D. J. G. Davies, Livestock Officer.

C. H. Koster, Senior Meat and Dairy Inspector.

R. J. Nesbitt, Meat and Dairy Inspector.

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